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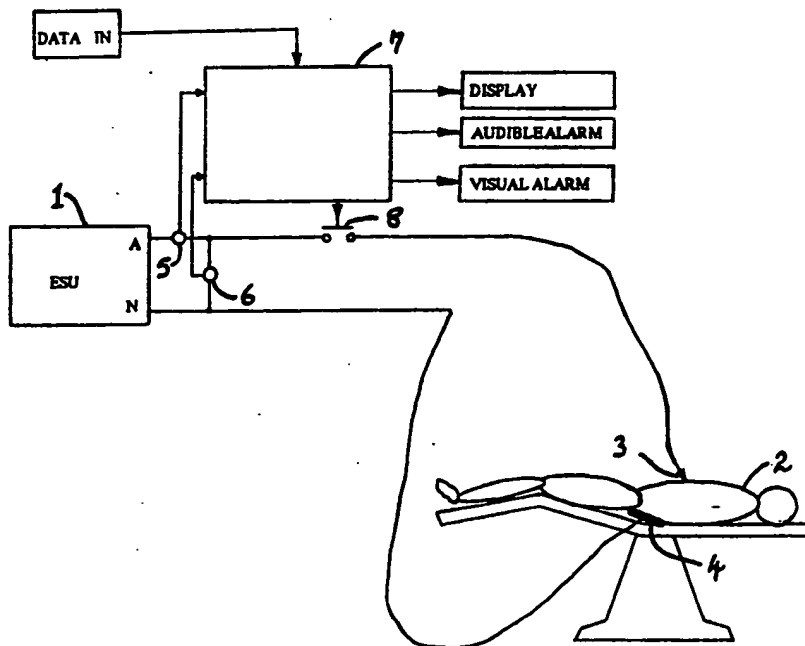
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(56) Documents cited  
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 UK CL (Edition J) A5R RHCC  
 INT CL<sup>\*</sup> A61B, A61N

(54) **Electro-surgical apparatus with body impedance monitoring**

(57) Surgical diathermy apparatus including two electrodes to be applied to the patient's body under operation, and means for applying a high-frequency alternating current to the electrodes to perform electro-coagulation or surgery. The equipment also includes means for sensing the instantaneous values of the voltage and current between the electrodes and for calculating the impedance of the total circuit in accordance with these sensed values. An automatic detector senses any impedance value above a pre-determined level and is arranged to produce a warning or control signal. This enables a surgeon to perform delicate, difficult operations even when the operation site is out of view.



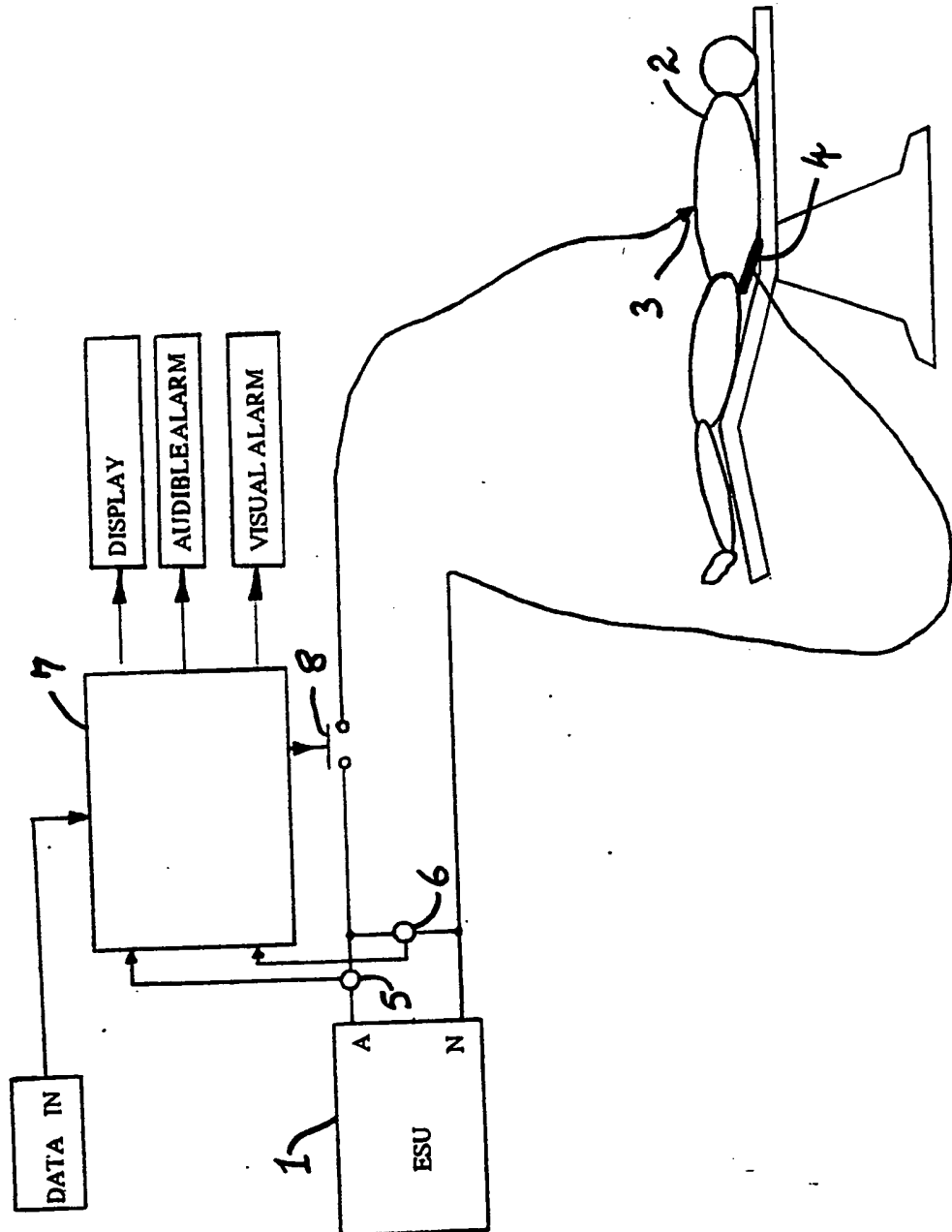
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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"Surgical Diathermy Instruments"

This invention relates to apparatus designed for use in surgical diathermy which expression is intended to include related applications of coagulation and falguration in addition to the  
5 direct surgical cutting of tissue. The term "diathermy" as currently used relates to the treatment of the human (or animal) body by heat, the heat being produced or generated directly by flow of electric current through the body. For this  
10 purpose it is usually necessary to employ two electrodes and in a typical application there is a large area "neutral" electrode positioned at some point below the body where it is supported, and another "active" electrode of small size which is  
15 carefully positioned by the surgeon at the position where diathermy is needed.

The electric current is normally relatively high-frequency and may be within various different ranges, for example between about 300 and 3,000  
20 kHz or up to 3 mGh or 5 mGh. The higher frequencies are usually employed for surgical operations involving the cutting of tissue.

Electro-coagulation is frequently employed in all surgical operations to close off severed blood vessels for haemostasis. Falguration is a modified form of this haemostasis procedure which  
5 involves a degree of charring of the tissue with deep necrosis.

Surgical diathermy is particularly advantageous in certain types of surgical operation and one procedure in particular is of major  
10 interest, trans-urethral resection of the prostate (T.U.R.). This involves the use of an electro-surgical diathermy cutting "loop" introduced into the bladder via a cystoscope, the bladder being filled and flushed with a low conductivity fluid.  
15 It is important that only prostate tissue is cut into during the resection, and that the tissue of the surrounding capsule is not cut. Should this occur blood vessels which pass through the capsule tend to retract back into this tissue and the  
20 bleeding is hard to stop. Longer hospitalisation is then necessary and additional blood transfusions may be required with their attendant risks.

At certain times during the procedure the exact point of application of the cutting loop may of

necessity be out of view of the surgeon and skill and experience are important factors in ensuring a successful outcome. Nevertheless, even in experienced hands, cutting of the capsule can  
5 occur.

It is an object of the invention accordingly to provide an improved form of diathermy apparatus which will assist the surgeon in carrying out delicate or difficult surgical procedures such as  
10 T.U.R.

The invention is based on the appreciation that there are variations in the electrical impedance in different parts of the body and by sensing changes in the impedance sensitively and rapidly  
15 it may be possible to give the surgeon warning or to cut off or reduce the electrical current to the electrodes automatically. Obviously this can be of benefit especially when the surgeon is unable to see the electrode directly.

20 Broadly stated the invention consists in surgical diathermy apparatus comprising two electrodes or probes to be applied to the body under operation and means for supplying an alternating current to the electrodes, with means for sensing the impedance of  
25 the body between the electrodes, and a sensor for

detecting any value or change in impedance above a  
determined level and for producing a warning or  
control signal. Since the impedance cannot normally  
be sensed directly the apparatus preferably includes  
5 means for calculating the impedance in accordance  
with the voltage and current between the electrodes.  
Since the current is alternating at a high frequency  
the apparatus also preferably includes means for  
detecting the R.M.S. value of the voltage and/or  
10 current between the electrodes.

The apparatus may include means for  
maintaining a substantially constant voltage supply  
across the electrodes and means for sensing the  
value of the current flowing. In such case the  
15 apparatus itself will not normally include means  
for measuring the voltage.

In any case the apparatus is preferably  
arranged to generate an audible or visual alarm  
and/or a warning display. For example there may  
20 be a visual warning display adjacent the active  
electrode.

According to another preferred feature  
of the invention the apparatus includes a high-  
speed electrical switch in the circuit of the  
25 electrodes and means for automatically opening or  
adjusting the switch circuit in response to a  
predetermined change in the sensed impedance so as

to shut off or modify the current in the electrode.

The invention may be performed in various ways and one particular embodiment will now be described, by way of example, with reference to the accompanying drawing which is a diagrammatic illustration  
5 of a surgical diathermy unit according to the invention.

In this illustration the patient 2 is shown lying on a table with the neutral electrode 4 below and the active electrode or cutting loop 3 above.  
10 The electrode surgical unit 1 is in effect a radio-frequency generator capable of supplying current at the required frequency and voltage to the electrode leads of terminals A or N. The actual frequency may vary considerably as outlined above and different  
15 frequencies may be used for different purposes. Accordingly the unit will normally include a frequency changing switch. It may also be required to alter the voltage and current supplied to the electrodes and voltage and current control devices will also  
20 be incorporated. Alternatively, or in addition, there may be devices to maintain a preselected value of current or voltage, especially a constant voltage supply control. The power generating unit is connected to a mains supply, but will incorporate

isolating or insulating systems so that the electrode voltage is "floating" and the patient is not at risk of being exposed to mains voltage.

In this particular example the system includes  
5 a voltage measuring device 6, and a current measuring device 5 in one of the leads, these two devices being connected into a control unit 7, which includes a calculating or processing section for deriving the instantaneous value of the impedance between  
10 the electrodes based on the measured current and voltage. Since the electrode current is of very high frequency it is important that these measured values should be R.M.S. (Root Mean Square). The control unit 7 is arranged to operate a warning or  
15 trip circuit which will automatically energise a warning display or an audible or visual alarm. The visual alarm may, for example, be incorporated into the actual active electrode 3 so as to be immediately visible to the surgeon.. Alternatively,  
20 or in addition, the control circuit 7 may be arranged to actuate a switch 8 to open the electrode circuit and immediately cut off the electrode current.

The value at which the automatic circuit  
25 "triggers" may vary in accordance with a number



of different parameters. For example, the applied frequency or voltage of the power unit 1, or the particular part of the body under operation may result in different impedance values and different settings of the "trigger" value.

It may be possible to obtain a useful indication of changes of body impedance by means other than direct voltage or current measuring or sensing devices. For example, an accurate high-speed power detector sensing the energy in the electrode circuit will react quickly to changes in impedance.

CLAIMS

1. Surgical diathermy apparatus comprising two electrodes or probes to be applied to the body under operation and means for supplying an alternating current to the electrodes, with means  
5 for sensing the impedance of the body between the electrodes, and a sensor for detecting any value or change in impedance above a determined level and for producing a warning or control signal.
2. Apparatus according to Claim 1,  
10 including means for calculating the impedance in accordance with the voltage and current between the electrodes.
3. Apparatus according to Claim 2,  
including means for detecting the R.M.S. value of  
15 the voltage and/or current between the electrodes.
4. Apparatus according to any of the preceding claims, including means for maintaining a substantially constant voltage supply across the electrodes and means for sensing the value of  
20 the current flowing.
5. Apparatus according to any of the preceding claims, in which the apparatus is arranged to generate an audible or visual alarm and/or a warning display.

6. Apparatus according to Claim 5, in which the equipment includes a visual warning display adjacent the active electrode.

5 7. Apparatus according to any of the preceding claims, including a high-speed electrical switch in the circuit of the electrodes and means for automatically opening or adjusting the switch circuit in response to a predetermined change in the sensed  
10 impedance so as to shut off or modify the current in the electrode.

7. Surgical diathermy apparatus substantially in any of the forms described with reference to the accompanying drawings.

Amendments to the claims have been filed as follows

1. Surgical diathermy apparatus comprising two electrodes or probes to be applied to the body under operation and means for supplying an alternating current to the electrodes, with means  
5 for sensing the impedance of the body between the electrodes, and a sensor for detecting any value or change in impedance above a determined level and for producing a warning or control signal.
2. Apparatus according to Claim 1,  
10 including means for calculating the impedance in accordance with the voltage and current between the electrodes.
3. Apparatus according to Claim 2,  
including means for detecting the R.M.S. value of  
15 the voltage and/or current between the electrodes.
4. Apparatus according to any of the preceding claims, including means for maintaining a substantially constant voltage supply across the electrodes and means for sensing the value of  
20 the current flowing.
5. Apparatus according to any of the preceding claims, in which the apparatus is arranged to generate an audible or visual alarm and/or a warning display.

6. Apparatus according to Claim 5, in which the equipment includes a visual warning display adjacent the active electrode.

5 7. Apparatus according to any of the preceding claims, including a high-speed electrical switch in the circuit of the electrodes and means for automatically opening or adjusting the switch circuit in response to a predetermined change in the sensed  
10 impedance so as to shut off or modify the current in the electrode.

7. Surgical diathermy apparatus substantially in any of the forms described with reference to the accompanying drawings.

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